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## FUTURE NORTH AMERICAN AIR TRAFFIC CONTROL SYNERGY

Human Factors Solutions

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Electronic Systems Division  
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## **1.0 INTRODUCTION**

### **1.1 Background**

The National Airspace System (NAS) Plan and the Canadian Airspace Systems (CAS) Plan contain modernization projects affecting most elements of the North American airspace system and have potentially significant impacts on system users. Further, the airspace systems of the U.S. and Canada have considerable points of interdependency and inter-relationship. As befitted their independent national interests, each country developed their modernization requirements in relative isolation from one another.

The respective defense agencies of these countries have been only minimally involved with modernization plans and not in a structured organizational manner. The military is vitally interested in the operation, planning, and potential long-range interface with NAS and CAS Plan projects. Individual defense agencies have a critical interest in ensuring adequate command, control, and communications infrastructure and interface for the defense missions in North America. Trans-century planning needs to be initiated which ensures the involvement of both civil and military agencies from each country.

### **1.2 Purpose**

This innovative research effort was proposed in response to the challenge of integrating the 'lessons learned' in developing the American and Canadian airspace systems into the planning process for an interoperable, trans-century, North American airspace system. The intent was to identify opportunities for increasing efficiencies, reciprocal benefits, and co-operation between the U.S. and Canada which would result in a proposed functional organizational matrix. This 'strawman' organization would

provide DoD with a framework for mutual airspace management gains between the U.S. and Canada.

### **1.3 Scope**

This report proposes the points of interoperability to facilitate exchange of lessons learned, including possible out-year technological applications. The potential for research and development gains are also outlined. The major interface issues between Canada and the United States, from a technological and an organizational perspective, are described.

The report references - but does not assess - the technology of the current and planned NAS and CAS modernization plans.

The issues of airspace management and inter-organizational relationships relating to NATO and other international organizations do not form part of this study.

## 2.0 SIGNIFICANCE OF THE PROBLEM

### 2.1      Airspace System Responsibility

The Administrator of the Federal Aviation Administration (FAA) is charged with the responsibility to provide for a common system of ATC and air navigation for both military and civil aircraft, and for the consolidation of research and development (R&D) with respect to the system throughout the U.S. The Administrator must also provide for long-range planning of the system that will meet civil needs and national defense requirements. In Canada, the Director General, Air Navigation of Transport Canada has like responsibilities and the same requirement to provide for long-range planning of a common civil and military air traffic system. In carrying out these responsibilities the FAA has produced the NAS Plan, and Transport Canada the CAS Plan, which develop the technical scenarios for their respective nation's air transportation system infrastructure through the end of the century. The FAA is also examining post-2000 issues, through the office of the Associate Administrator for Advanced Design and Management Control (ADM-1); and in conjunction with the DoD through the Joint Program Office of the Assistant Secretary of Defense for Command, Control, Communications and Intelligence (ASD/C3I).

Both the U.S. and the Canadian military share the majority of airspace with civil users and have designated areas for exclusive military operations. Planned improvements scheduled through the year 2000 will affect both country's military flying missions from the standpoint of the military being a primary user of the system; and will affect the military role as co-providers of ATC services.

With thousands of miles of shared border and airspace due to Canada's geographical location adjacent to the U.S., Canada's defense responsibility for the North Atlantic area, and Canada's strategic northern defense installations, there is considerable albeit ad hoc, co-operation and sharing of information between various government departments and agencies. In particular, the FAA and Transport Canada have shared information in the

development of their aviation system plans. The implementation of common new programs such as Mode S, precision instrument approach systems (MLS), and collision avoidance systems (TCAS), are examples of projects which are appropriate for mutual information exchange and potential technology transfer. It is logical to conclude that efficiencies could be achieved through formal interface between the U.S DoD and the Canadian DND in order to take full advantage of such technological developments as they relate to the military mission.

## **2.2 Current Airspace System Management**

The term "airspace management" in proper context is much broader in application than just the safe and efficient utilization and allocation of physical airspace. The context within which the Air Force and other military services must view airspace management encompasses the entire modernization effort in the sense that the NAS Plan (and the CAS Plan in the case of Canadian military applications) details the technology which will ultimately support the management of the airspace in the transcentury timeframe. To this end, potential exists for DoD and DND to identify shared concerns and possibly exploit technology improvement potentials.

U.S. Air Force input to DoD planning, as it relates to the NAS for airspace management in the post-2000 timeframe has begun in earnest. Some initial efforts accomplished by the U.S. Air Force and other military agencies to establish management structures and initiate actions for providing input to U.S. System planning include:

- Establishment by DoD, and located at FAA headquarters, of a joint requirements office with representatives for each military service.
- Establishment of a joint services acquisition panel to address modernization issues.
- Establishment of a joint program requirement office to ensure appropriate "lead" service response and resource availability.

- A DoD recommendation regarding the proposed Area Control Facility Concept which best meets all military ATC needs and survivability requirements.
- Funding by DoD for a study of the interoperability issues between FAA and DoD air traffic control systems.
- Provision of an Air Force staff resource for the FAA National Airspace Review (NAR) which examined the operational implications and requirements resulting from NAS Plan implementation.

The Canadian military agencies have also initiated co-operative programs and efforts between the DND and Transport Canada to facilitate mutual objectives in the management of airspace issues which include, but are not limited to, the following:

- Participation in the RNAV Task Force and the Helicopter Working Group of the Canadian Airspace Review (CAR).
- Participation in the Canadian Automated Air Traffic System (CAATS) program to ensure mutual understanding of requirements as well as hardware compatibility.
- Joint responsibility for TP 308: Criteria for Development of Terminal Procedures.

These examples of efforts to structure appropriate management schemes demonstrate proper concern for co-operative airspace system plan interface and requirements considerations. However, this idiosyncratic approach could be improved to achieve more effective and efficient liaison. Further, these types of efforts have not encompassed a comprehensive North American technology transfer structure.



## 3.0 TECHNICAL REPORT

### 3.1 First Technical Objective

The first technical objective was to answer the question: Why is a rapport and continued interface between DoD and DND necessary and beneficial to both defense agencies?

#### 3.1.1 Attacking the Problem

To accomplish the necessary research, the work plan called for the following procedures:

- identify the key offices and points of contact within each of the respective military defense agencies currently responsible for long-range program definition, conceptual development, R&D, and planning for military ATC and airspace systems.
- interview each of the identified DoD and DND representatives identified and collect charters, program objectives, and mission statements;
- analyze existing charters and missions statements for commonality, redundancy between and among the USAF/DoD and DND, as appropriate to their respective modernization effort; and
- identify those management functions where technology exchange potential or informational opportunities exist as a result of identified commonality of organizational schematics based on mission statements and objectives between both DoD and DND, including a strawman matrix.

Interviews were held at all levels with the persons responsible for the management functions being targeted for study throughout the various service branches. Similar interviews were held with DND representatives. This process highlighted the lack of effective inter-organizational mechanism for DoD components to co-ordinate ATC systems planning, requirements definition, and acquisition activities with DND's modernization efforts.

### **3.1.2 Findings**

The work of Phase I reveals dramatic differences in the DOD/DND ATC system operational requirements, capacity issues, and R&D emphasis, as well as known deltas of sheer size, complexity, and funding levels. However, there are also common requirements to operate an ATC and airspace management system and to provide for its development, enhancement and life cycle management. Although the U.S. military services have a tactical ATC mission not shared by their Canadian counterparts, sufficient commonality exists between DOD/DND ATC mission responsibility to warrant formal interface between the two in support of their common military/civil ATC responsibilities and the inherent need of life cycle management for long range planning.

DoD operates/owns approximately 20% of the NAS in order to support training, operational exercises, etc. Consequently, their controllers handle a similar percentage of the civilian air traffic. As co-providers they are intimately concerned with the modernization of AT services and equipment; and the vision of NAS in the twenty-first century. While the DND is also concerned with the evolution of the airspace system, their ATC operational requirements are a significantly smaller percentage of all Canadian air traffic services and equipment. For example, the Canadian military have significantly fewer air traffic controllers than does the DOD. Due to the vast amounts of unsettled territory Canada does not experience capacity problems, a major issue for the DOD in terms of airspace volume needed for military readiness requirements. Also the DND controllers handle limited civilian operations. Some of the very significant concerns

in the U.S. which have brought the military into such a vital role of the management of the airspace have not yet occurred in Canada.

The differences between these sovereign states is also evident in their R&D budgets. In 1987, the latest year for which comparable figures are available, Canada spent 1.35 per cent of its gross domestic product on research and development well short of the 2.69 percent in the United States. R&D budgetary constraints in both countries is, by itself, however, a basis for benefiting from shared technology, particularly in light of the very limited cost associated with periodic technical interchange meetings and unclassified document exchange. In the U.S. each of the four services have identified an office responsible for long-range ATC planning. The USAF has also staffed 3 full-time positions to address ATC long-range operational planning and R&D. After two years of informal meetings between each services' representatives, a panel was chartered under the Secretary of Defense for C3I - the Airspace Control Planning Panel. The panel has an advisory member from the FAA in order to remain in sync with their advanced system design efforts.

In Canada, operational requirements identified by all three services are handled by the air side of DND, specifically DARTS (Directorate Air Regulations & Traffic Services). This group is responsible for all air operations support from regulations to licensing to environmental issues to equipment procurement to manpower and training to national and international liaison. Interface with Transport Canada occurs in an unstructured and informal manner at various levels within the air side organization. Primarily, however, the interface is through DARTS and DAT (Director of Air Traffic). There is no organization established to look at post-CAS Plan issues.

### **3.1.3 Conclusions**

1. Continued rapport and interface between DoD and DND is beneficial as:
  - both have civilian ATC responsibilities

- both share an interest in shaping the long-term airspace system
- increasing budgetary constraints promote joint R&D potential

2. The primary potential for technology exchange exists between the DND DARTS functional group and the DoD ASD/C3I on the military side; and between the FAA ADM-1 and TC DG Air Navigation Systems on the civilian side.

### **3.2 Second Technical Objective**

The second technical objective was to answer the question : What is the most effective way to address the mutual opportunities to augment each country's military services planning for airspace management?

#### **3.2.1 Attacking the Problem**

The tasks undertaken to accomplish this objective included:

- Identify current studies, reports, and papers on NAS and CAS Plan efforts as well as DoD and DND documents to include any post-2000 military ATC or airspace management plans which have been identified for future interface opportunities.
- Review appropriate documents to identify potential opportunities relative to the sharing of information and technologies between DoD and DND.
- Detail how the management functions identified in Task 1 will provide for long-range planning strategies and identify opportunities for DoD and DND interface to develop mutual understanding of goals and objectives.

### 3.2.2 Findings

There were a limited number of current studies found which could affect the military ATC mission as annotated below:

- The Advanced Aviation System Design: An FAA, DoD, NASA study which considers the nine elements for global air navigation control and describes the technology of the future and their effects on the operational concepts for air traffic control in the twenty-first century.
- The Environment of the Twenty-First Century: An FAA-sponsored study to define the concept of operation based on the end state modernization plans within the U.S. civil and military communities.
- Future Flight: An FAA-developed concept which explores the possible integrated use of technological developments to describes potential outyear operational scenario.
- 1988 Boston Symposium papers and the 1989 Moscow Symposium papers represent the type of out-year concepts being discussed :
  - A Historian in 2020 Reviews the Development of Aviation Technology - Edward W. Stimpson, General Aviation Manufacturing Association
  - An Airplane Manufacturer Looks at the Market- Thomas Craig, Boeing Commercial Airplane Company
  - Views of a Financial Analyst - Wolfgang Derniach, UBS Security, Inc.
  - The Aviation Weather System in the 21st Century: Advanced Weather Sensing, Assimilation, and Artificial Intelligence, To Maintain Safety and Efficiency of Flight - John McCarthy, NCAR

- A Boeing View of the 21st Century - Donald W. Hayward, Boeing Commercial Airplane Company
- Transport Aircraft for the 21st Century - John Morris, Douglas Aircraft Company
- General Aviation in the Year 2020 - Ronald D. Neal, Beech Aircraft Corporation
- Tilt Rotors -- High-Speed Shuttles for the 21st Century - Ron R. Rebar, Bell Helicopter Textron, Inc.
- A Modular Airplane - Al Lupinetti, Federal Aviation Administration
- High-Speed Unmanned Freighter Concept - S. Fred Singer, Department of Transportation
- Airport Odyssey 2020 - Agam Sinha, MITRE
- Airports 2020 - Robert Baxter, Bechtel Civil, Inc.
- The Distributed Airport Concept - Geoffrey Gosling, University of California at Berkley
- Gate Operations -- Standardization and Automation Will Result from the Need to Reduce Operating Costs and Increase Efficiency  
- C.F. Booth, Peat Marwick
- Integrated Vertiport Systems for Metropolitan Areas - Wilton J. Smith, Attorney
- The Air Traffic Control Environment in 2010 - Captain Guy C. St Sauveur

- The ATC System in the 21st Century - Tatiana Anodina, USSR Ministry of Civil Aviation
- Future Air Traffic Systems in France - Daniel Tenenbaum, DGAG
- Ranging and Processing Satellite (RAPSAT) - Curtis Shively, MITRE Corp.
- A Demonstration System to Investigate Advanced Air Traffic Management Concepts - Dirk Duyachever, Eurocontrol
- ATC in 2050 and How to Get There - J. Lynn Helms
- Future Air Traffic Systems in Japan - Paul Muto, NEC
- Automated Air Traffic Control in the 21st Century - AERA 4 - and Beyond, Louis A. Klelman, Engineering Design Consultant
- Terminal Ait Traffic Control in the 21st Century and Beyond - Jerry D. Welsh, MIT
- Air Traffic Managment - John J. Fearnsides, MITRE Corp
- Human Performance Problems in 20th Century ATC: What We Must Not Do in the 21st - Phyllis Kayten, National Transportation Safety Board
- Aircraft Management for the 21st Century - Examining the Flight Crew's Role - Robert Burley, Northwest Airlines
- Rouse, Search Technology, Inc.
- Pilot Controller Relationships in the 21st Century: Who's in Charge? - Jack Howell, Airlines Pilots Association.

In addition the following on-going efforts on long-range planning strategies are underway:

- The DoD NASDAP (National Airspace Systems Defense Acquisition Panel) which co-ordinates integration of those portions of the FAA NAS Plan that affect the development, acquisition, and life-cycle support of DoD fixed-based ATCALS (Air Traffic Control and Landing Systems);
- The DoD Research, Engineering and Development Advisory Committee which provides advice and recommendations to the FAA on the needs, plans, objectives, approaches, contents, and accomplishments with respect to the aviation research program, including similar research being conducted outside the FAA.
- Automated Tactical Aircraft Launch and Recovery System (ATALARS): An USAF-sponsored concept development effort to provide a survivable, secure and integrated ATC capability within the total battlefield management system.
- Alaskan Command and Control System Military Automated Network (AC2SMAN): USAF Alaskan Air Command system which provides tactical information for battle management through networked users workstations.

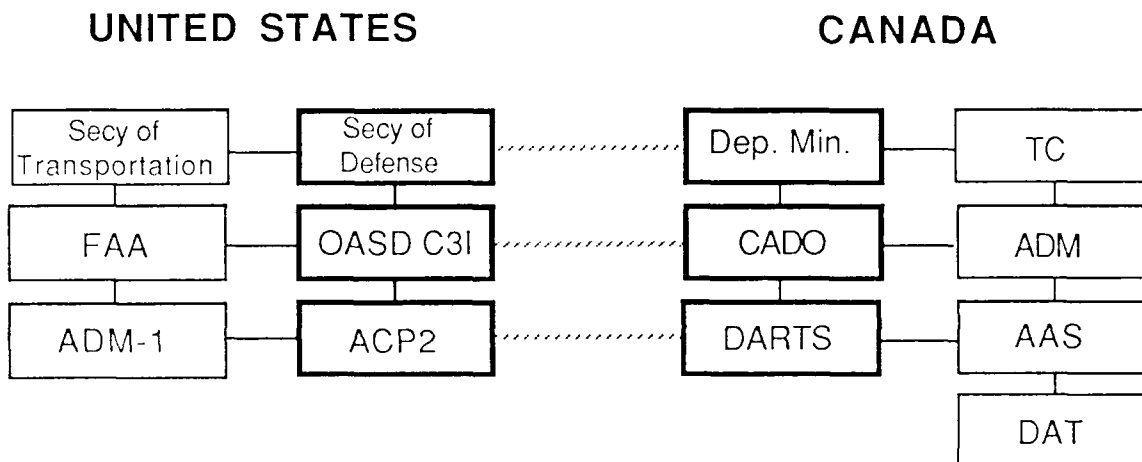
Preliminary searches of electronic data bases indicate that a carefully constructed survey/search instrument, keyed to the many technologies that would support these plans, would be fruitful. The hundreds of U.S. federal laboratories which do research should be analyzed for projects which could support future air traffic control concepts. Potential opportunities for sharing are the emerging technologies for communication, navigation, surveillance and artificial intelligence. The political and budgetary cutbacks in Canadian defence spending, as well as those in the U.S., have resulted in civilian airspace system-related procurements influencing Canadian and U.S. military procurement decisions in both scheduling and equipment. Further, out-year planning is not



receiving high priority due to the essential nature of more near term problems.

### 3.2.3 Conclusions

1. Trans-century planning issues can properly reside within the existing air support functional offices within DoD and DND. The following figure depicts the 'strawman' organizational matrix for interface between DoD and DND.



2. Formalized interface and sharing of technologies and high R&D priority items will result in the most efficient solutions to synergistic DOD/DND issues.